

## CLAIMS

What is claimed is:

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1. A method of identifying crosstalk in a received signal, the method comprising:  
collecting received data corresponding to the received signal from a receiver;  
collecting primary data from a primary transmitter;  
collecting crosstalk data from a crosstalk transmitter;  
10 identifying a crosstalk function corresponding to the crosstalk data.

2. The method of claim 1 further comprising determining a first estimate of a timing  
offset between the received data and the crosstalk data.

- 15 3. The method of claim 2 wherein determining the first estimate of the timing offset  
comprises cross-correlating the received data and the crosstalk data if the timing offset is  
other than zero.

4. The method of claim 1 wherein identifying the crosstalk function comprises  
20 performing an estimation from the group comprising a standard least-squares estimation and  
a weighted least-squares estimation.

5. The method of claim 4 wherein performing an estimation includes jointly  
determining an estimate of the timing offset between the received data and the crosstalk data  
25 and identifying a crosstalk function corresponding to the crosstalk data.

6. The method of claim 1 further comprising:  
collecting a plurality of sets of crosstalk data from a plurality of crosstalk  
transmitters, including a first set of crosstalk data from a first crosstalk transmitter;  
30 identifying a crosstalk function corresponding to the first set of crosstalk data.

7. The method of claim 6 further comprising determining a first estimate of a timing  
offset between the received data and the first set of crosstalk data.

8. The method of claim 1 further comprising:

collecting a plurality of sets of crosstalk data from a plurality of crosstalk transmitters, the plurality of sets of crosstalk data comprising a set of strong crosstalk signal data corresponding to a strong crosstalk signal and a set of weak crosstalk signal data

5 corresponding to a weak crosstalk signal;

determining whether a timing offset exists between the received data and the set of strong crosstalk signal data;

generating a first estimate of any determined timing offset between the received data and the set of strong crosstalk signal data;

10 identifying a strong crosstalk function corresponding to the strong crosstalk signal data;

subtracting the strong crosstalk function from the received signal to generate a modified received signal;

15 determining whether a timing offset exists between the received data and the set of weak crosstalk signal data;

generating a first estimate of any determined timing offset between the modified received signal and the weak crosstalk signal data; and

identifying a weak crosstalk function corresponding to the weak crosstalk signal data.

20 9. The method of claim 2 further comprising subtracting the primary data from the received data prior to determining the first estimate of the timing offset between the received data and the crosstalk data.

25 10. The method of claim 1 further comprising performing multiuser detection using the identified crosstalk function.

11. The method of claim 1 further comprising provisioning communication lines in a DSL system in which the identified crosstalk function is identified.

30 12. The method of claim 1 further comprising performing DSL system diagnosis services for a DSL system in which the identified crosstalk function is identified.

13. The method of claim 1 further comprising providing DSL system maintenance services for a DSL system in which the identified crosstalk function is identified.

14. The method of claim 1 further comprising performing spectral management services for a DSL system in which the identified crosstalk function is identified.

5 15. A system for identifying crosstalk comprising:

- a first transmitter configured to transmit a first signal;
- a second transmitter configured to transmit a second signal;
- a receiver configured to receive a combined signal, the combined signal comprising the first signal and crosstalk interference from the second signal; and

10 - a processor comprising:

- a data collector in communication with the first transmitter, the second transmitter and the receiver, the collector configured to collect:

- a first signal data set corresponding to the first signal;
- a second signal data set corresponding to the second signal; and
- 15 - a combined signal data set corresponding to the combined signal;
- a crosstalk identifier connected to the data collector comprising:
  - a crosstalk response estimator configured to estimate the crosstalk interference present in the combined signal.

20 16. The system of claim 15 wherein the crosstalk identifier further comprises a first timing offset estimator configured to calculate a first estimate of a timing offset between the combined signal and the second signal.

25 17. The system of claim 16 wherein the crosstalk response estimator is configured to calculate a second estimate of the timing offset.

18. The system of claim 16 wherein the first timing offset estimator comprises a cross-correlator configured to perform a cross-correlation of the combined signal and the second signal to provide the first timing offset.

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19. The system of claim 15 wherein the crosstalk identifier comprises a least-squares estimator.

20. The system of claim 15 wherein the first transmitter and the receiver are part of a DSL communication system.

21. The system of claim 15 wherein the processor is located at a location remote from the first and second transmitters and the receiver.

22. The system of claim 15 wherein the first transmitter, the second transmitter and the receiver are modems.

23. The system of claim 15 wherein the processor further comprises a data conditioner, connected to the data collector, configured to resample collected data.

24. The system of claim 15 wherein the crosstalk identifier further comprises a data subtractor configured to subtract the first signal from the combined signal to generate an interference signal.

25. A crosstalk identifier comprising:

a collector configured to collect data from a primary signal transmitter, from a crosstalk signal transmitter and from a receiver;

a crosstalk estimator in communication with the collector, the crosstalk estimator configured to determine a first estimate of a crosstalk response in the data from the receiver.

26. The identifier of claim 25 further comprising a timing estimator connected to the collector, the timing estimator configured to determine a first estimate of a timing offset between the data from the receiver and the data from the crosstalk signal transmitter.

27. The identifier of claim 26 wherein the crosstalk estimator also is configured to determine a second estimate of the timing offset between the data from the receiver and the data from the crosstalk signal transmitter.

28. The identifier of claim 26 wherein the timing estimator comprises a cross-correlator configured to provide a cross-correlation of the data from the receiver and the data from the crosstalk signal transmitter to determine the first estimate of the timing offset.

29. The identifier of claim 25 wherein the crosstalk estimator comprises a least-squares estimator configured to determine the first estimate of the crosstalk response.

30. The identifier of claim 27 wherein the crosstalk estimator uses a least-squares estimator to determine a second estimate of the timing offset.

31. The identifier of claim 25 wherein the identifier is configured to be used at a third party site remote from the transmitters and the receiver.

32. A method for identifying crosstalk in a received signal caused by interference from a crosstalk signal, the method comprising:

collecting received data from a receiver that has received the received signal during a specified time period;

collecting primary data transmitted as a primary signal during the specified time period;

collecting crosstalk data transmitted as a first crosstalk signal during the specified time period;

subtracting the primary data from the received data to generate interference data;

determining a first estimate of a timing offset between the received signal and the first crosstalk signal, comprising cross-correlating the interference data and the crosstalk data;

identifying a crosstalk function corresponding to the crosstalk signal, comprising performing a least-squares estimation to identify the crosstalk function and the crosstalk signal using the interference data and the first estimate of the timing offset.

33. A method of dynamically managing spectra in a DSL system, comprising:

identifying crosstalk functions and characteristics in the DSL system;

transferring information concerning the identified crosstalk functions and characteristics to an entity controlling spectra in the DSL system;

controlling line spectra in modems in the DSL system.

34. The method of claim 33 wherein the step of controlling line spectra in modems in the DSL system comprises:

adjusting spectra in the DSL system to reduce crosstalk interference;

coordinating the use of spectra in the DSL system to reduce crosstalk interference.

35. The method of claim 33 wherein the step of identifying crosstalk functions and characteristics in the DSL system includes the step of identifying crosstalk in a received  
5 signal, identifying crosstalk in a received signal comprising:

collecting received data corresponding to the received signal from a receiver;  
collecting primary data from a primary transmitter;  
collecting crosstalk data from a crosstalk transmitter;  
10 identifying a crosstalk function corresponding to the crosstalk data.

36. A method of transmitter coordination in the signal level comprising:  
identifying crosstalk functions affecting a plurality of transmitted signals on a  
plurality of transmission lines;  
synchronizing the plurality of transmitted signals; and  
15 coordinating the plurality of transmitted signals to reduce crosstalk.

37. A method of receiver coordination in the signal level comprising:  
identifying crosstalk functions affecting a plurality of signals on a plurality of  
transmission lines;  
20 synchronizing the plurality of signal; and  
reducing crosstalk among the plurality of signals using digital signal processing.